Rick Hance

Engineering Note

Date: 8/17/2000
Rev Date:

Project: General Support
Doc. No: H000817A

Subject: Safety Review Documentation for HV System in SiDet 10% Test

Location: The high voltage system for the SiDet 10% test is contained in a single equipment rack located in the NE corner of the SiDet 10% test Area in the Lab C clean room as shown in figure 1. All of the equipment is in the form of VME HV modules containing high voltage "pods" and supporting VME infrastructure as shown in figure 2. The VME HV modules and pods were developed at Fermilab for Dzero Run I, and are now commercially available from BiRa Corporation. The Sidet installation uses Fermilab and BiRa components interchangeably.

AC Distribution: AC power for this temporary installation is supplied to the rack via a 25' extension cord plugged into a 208V 30A 3ph outlet on the west side of the room[1]. The 5-wire AWG 10 extension cord is routed overhead and supported by appropriate hangars. An AC distribution box mounted in the HV rack derives three 120V 1ph circuits and distributes them through 15A circuit breakers to outlets for the four VME power supplies PS-1 through PS-4 as shown in figure 3. Each VME power supply has a suitable fuse in its AC input circuit. The entire rack uses ≅ 6A per phase (2.2 kVA) from the 208V input[2]

DC Distribution: The four VME power supply assemblies PS-1 though PS-4 are shown in figure 4. They provide DC power to the four VME crates. These power supply assemblies are provided as complete packaged units by LAMBDA[3]. The assemblies are connected to the VME crates by harnesses designed to carry the maximum available currents from the power supplies[4].

Module Fusing: Each VME HV module uses 5 separate voltages from the VME backplane (+5V, ±12V analog, ±12V bulk). The +5V and the ±12V bulk use multiple VME pins in parallel as required to limit the current density to acceptable values. Each voltage is fused near the VME input connector as shown in figure 5.

Cooling: Forced-air cooling is provided by fans located under the VME crates and the Lambda power supplies. Whereas water cooled heat exchangers are normally used in the Dzero high voltage installations, the worst case operating conditions of this particular installation do not require it[5].

Fire Protection: The relay rack is fitted with side panels and rear door. The AC inputs in the four VME power supply assemblies are interlocked[6] to a smoke detector located in the top of the rack as shown in figure 6.

Discussion: The rack contains a total of 84 positive and 84 negative programmable high-voltage pods (channels)[7]. The pods are distributed over 22 VME modules plugged into four VME crates.

The Type 1 and Type 2 pods are rated at 5.5kV @ 2.0mA and -5.5kV @ 2.0mA respectively. However, for use with silicon detectors, the pods are limited to 100V @ 2.0mA and -100V @ 2.0mA via the front panel, screwdriver adjustable, HVmax potentiometer feature of the devices. The HV system is controlled by a software program via an ethernet connection and commercial processor modules located in each crate. The pods are operated at 60-80V for the test. The HV is extracted from the module's front panel connectors via red RG-58 cable with SHV connectors. The cables go to the HV patch panel rack shown in figure 1. From there, the HV is fanned out into twist-n-flat cable (AWG 28, 300 Vdc, 105°C). The twist-n-flat cable routes the HV to the interface rack shown in figure 1 and from there it is delivered to the detector.

Shock Hazard: The Dzero HV system has been extensively analyzed and reviewed for safety with respect to shock hazard[8]. In the worst case Dzero configuration at a maximum available voltage (5.6 kV), with extensive capacitive cabling (20, 135ft cables in parallel), the maximum current available with respect to time is well within safe levels. This particular installation, with its voltage and current limit of 100Vand 2mA respectively, and its short lengths of capacitive cable presents minimal or no shock hazard.

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE

SUBJECT	NAME	
South End of Lab C Clean Room SiDet 10% Test Area General Layout of Area with Location of HV Rack	R. Hance	
	DATE 8/18/00	REVISION DATE

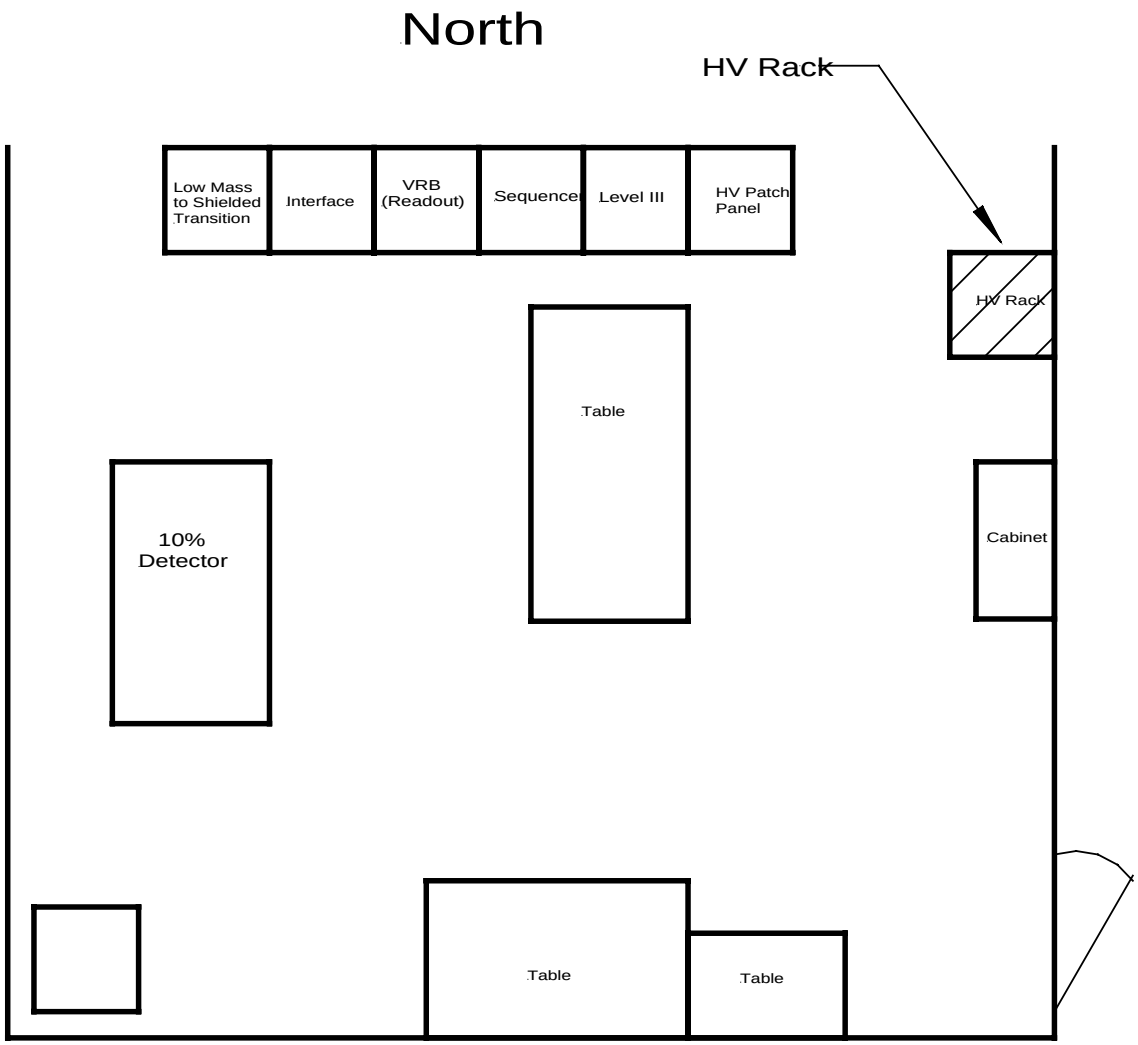


Figure 1

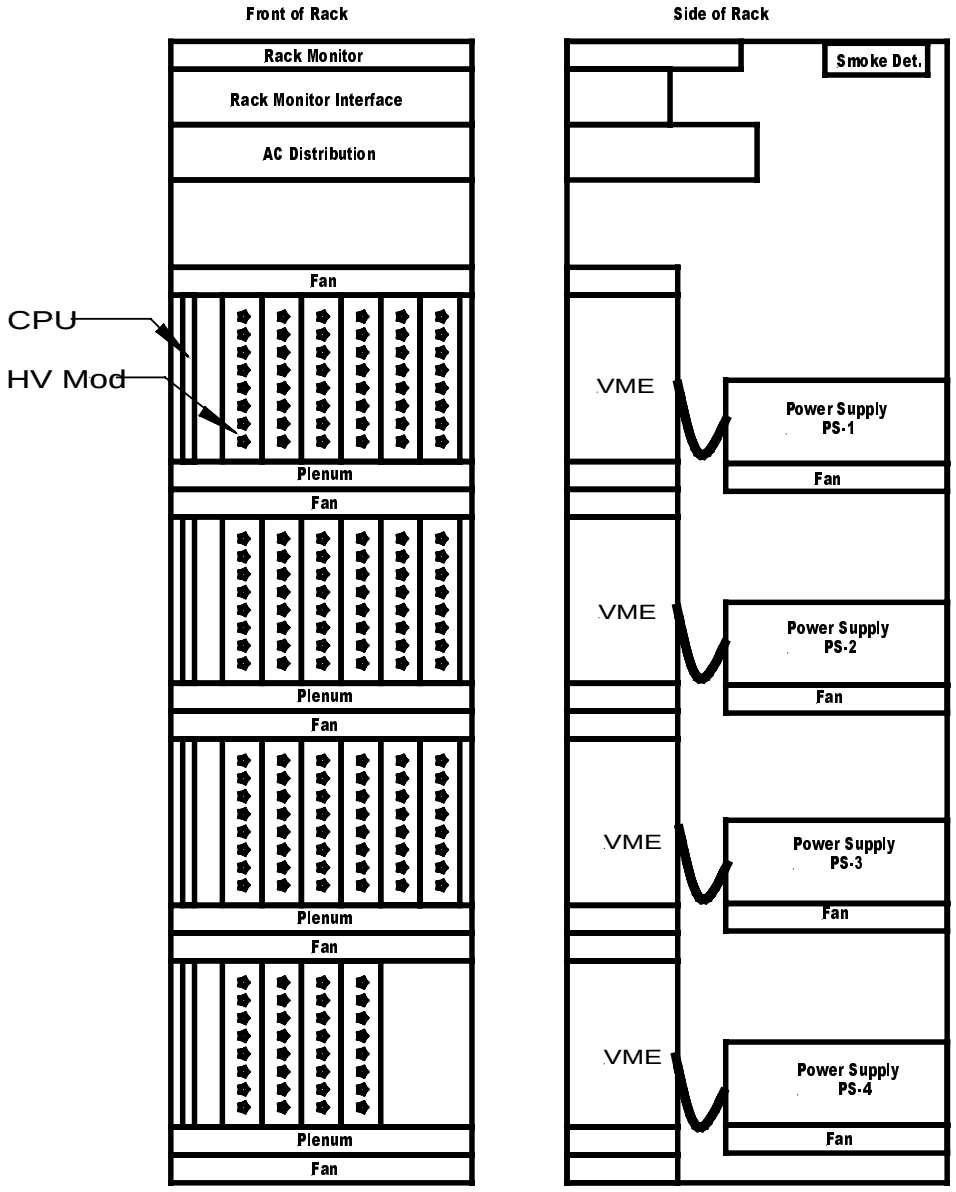

Front of Rack
Side of Rack
Rack Monitor
Rack Monitor Interface
AC Distribution
Fan
CPU
HV Mod
Plenum
Fan
Plenum
Fan
Plenum
Fan
Plenum
Fan
Smoke Det.
VME
Power Supply
PS-1
Fan
VME
Power Supply
PS-2
Fan
VME
Power Supply
PS-3
Fan
VME
Power Supply
PS-4
Fan

Figure 2

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
SUBJECT: AC Distribution Within HV Rack in SiDet 10% Test	NAME: R. Hance			
	DATE: 8/21/00	REVISION DATE		

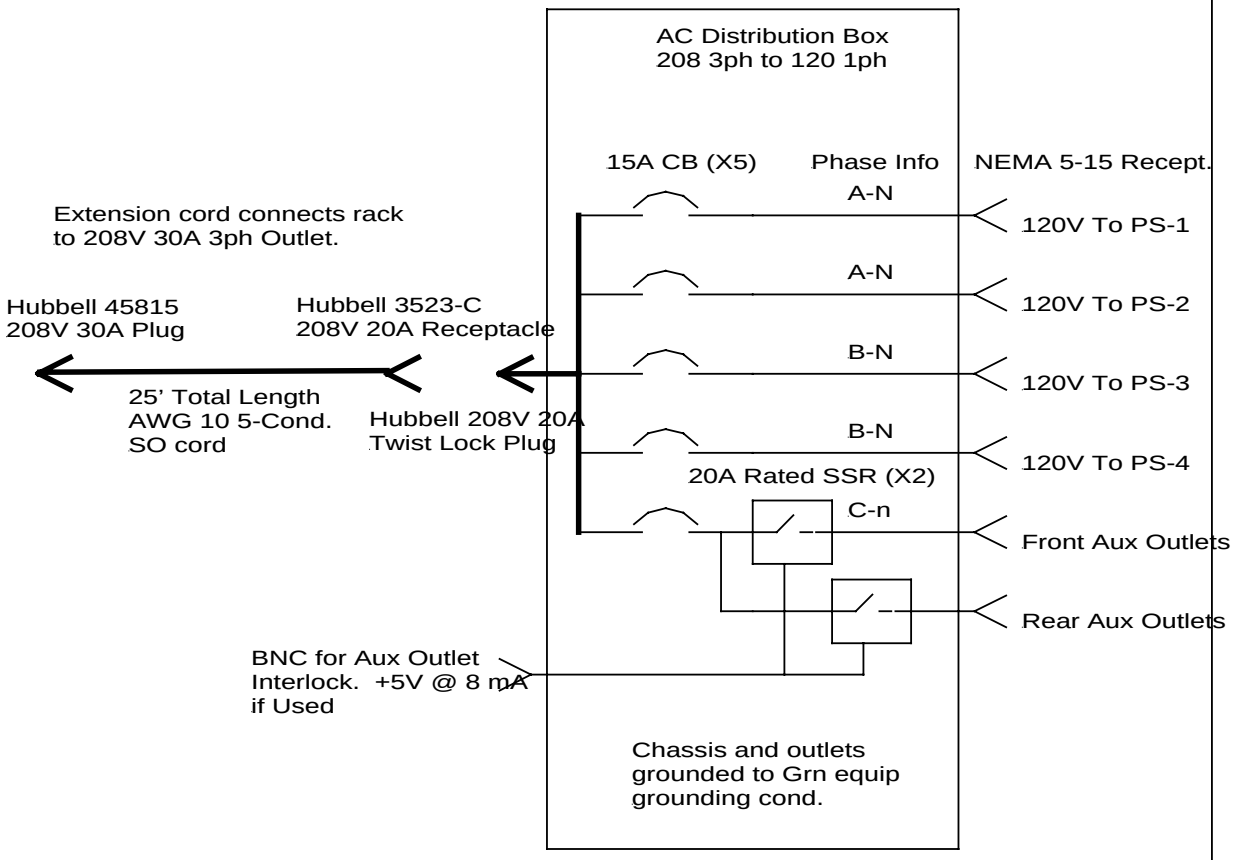


Figure 3

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
SUBJECT: DC Distribution Within HV Rack in SiDet 10% Test		NAME: R. Hance		
		DATE: 8/22/00	REVISION DATE	

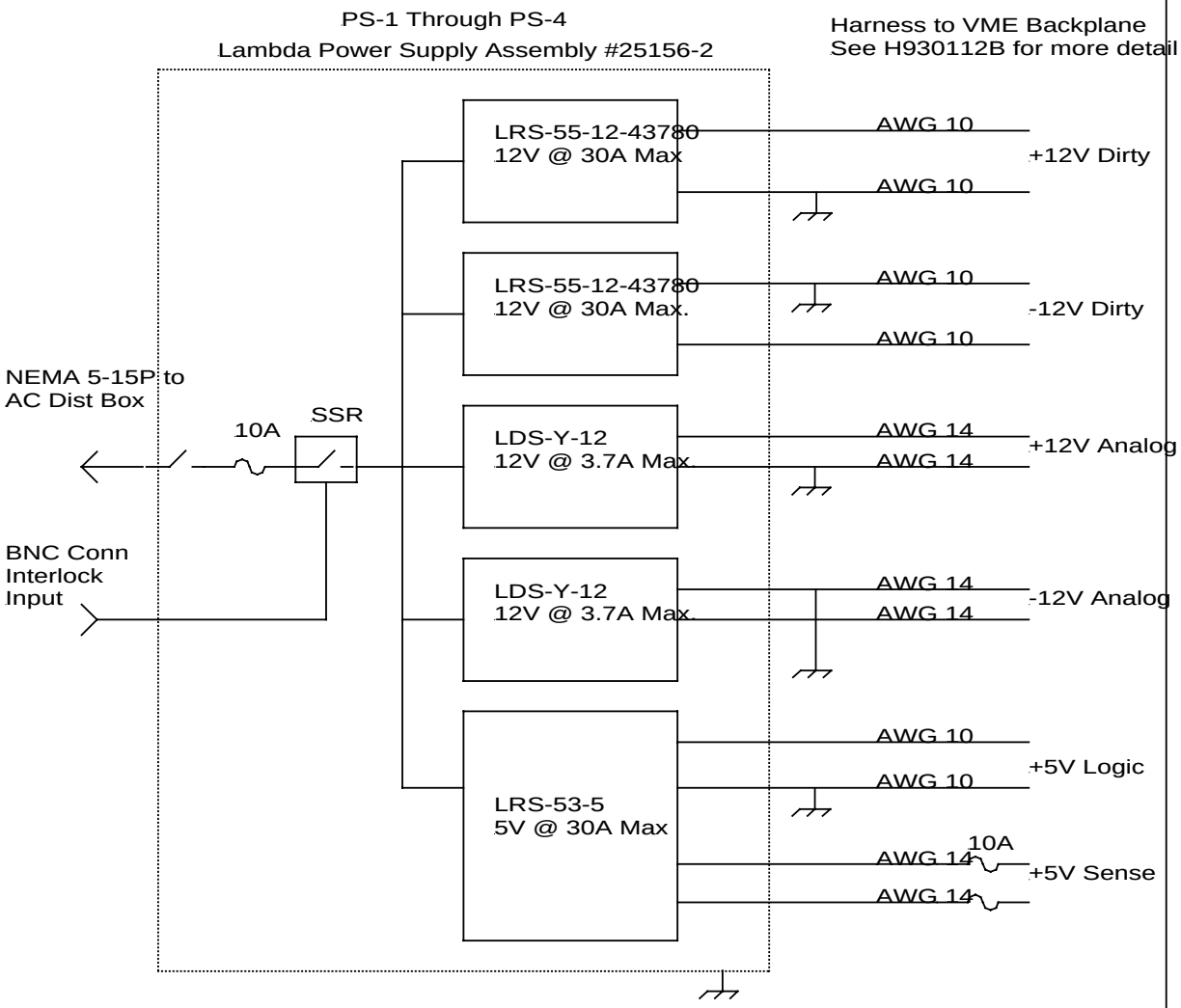
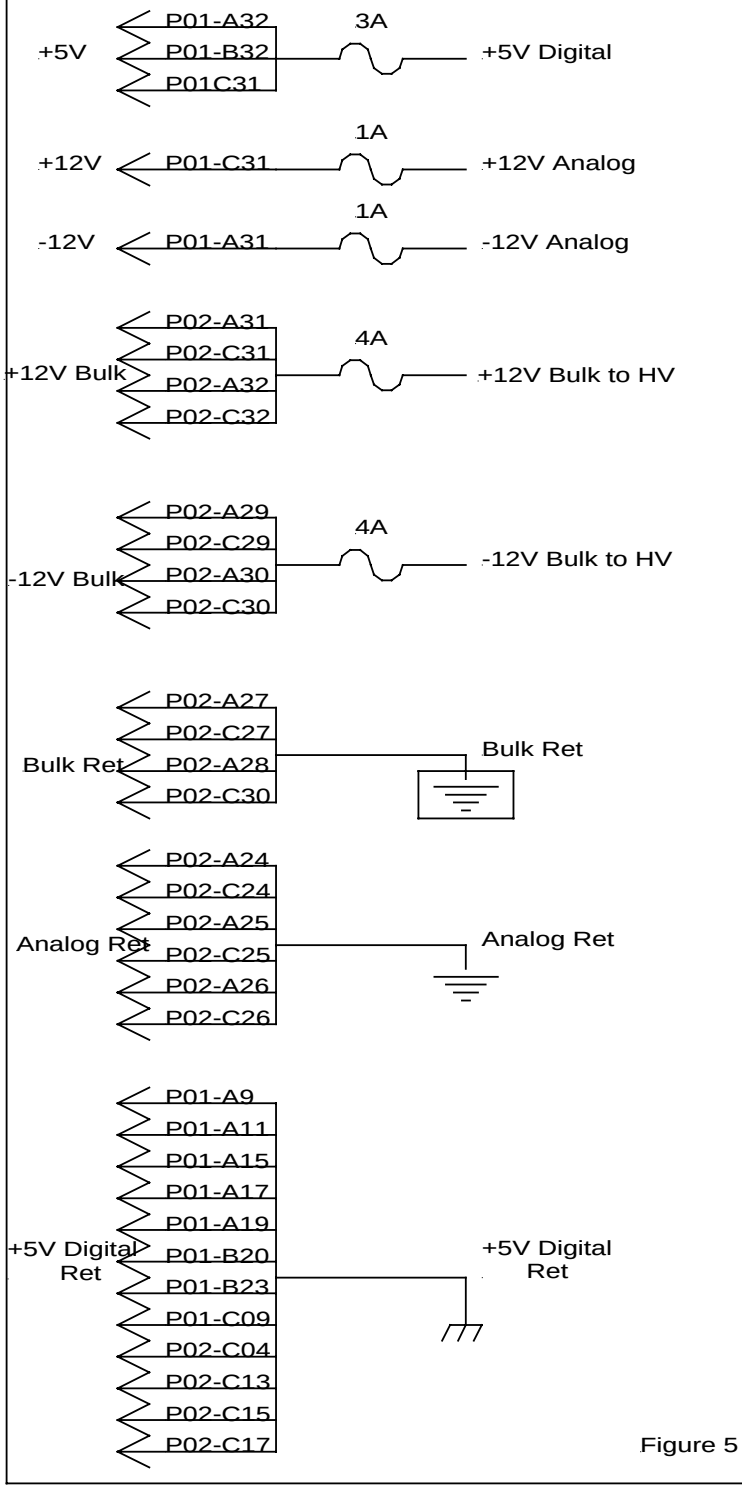


Figure 4



P0X-XXX refers to VMEbus pin designations.

Paralled pins are derated to 1.2A/pin at 60 deg C. per IEEE 1014 VME standard.

Figure 5

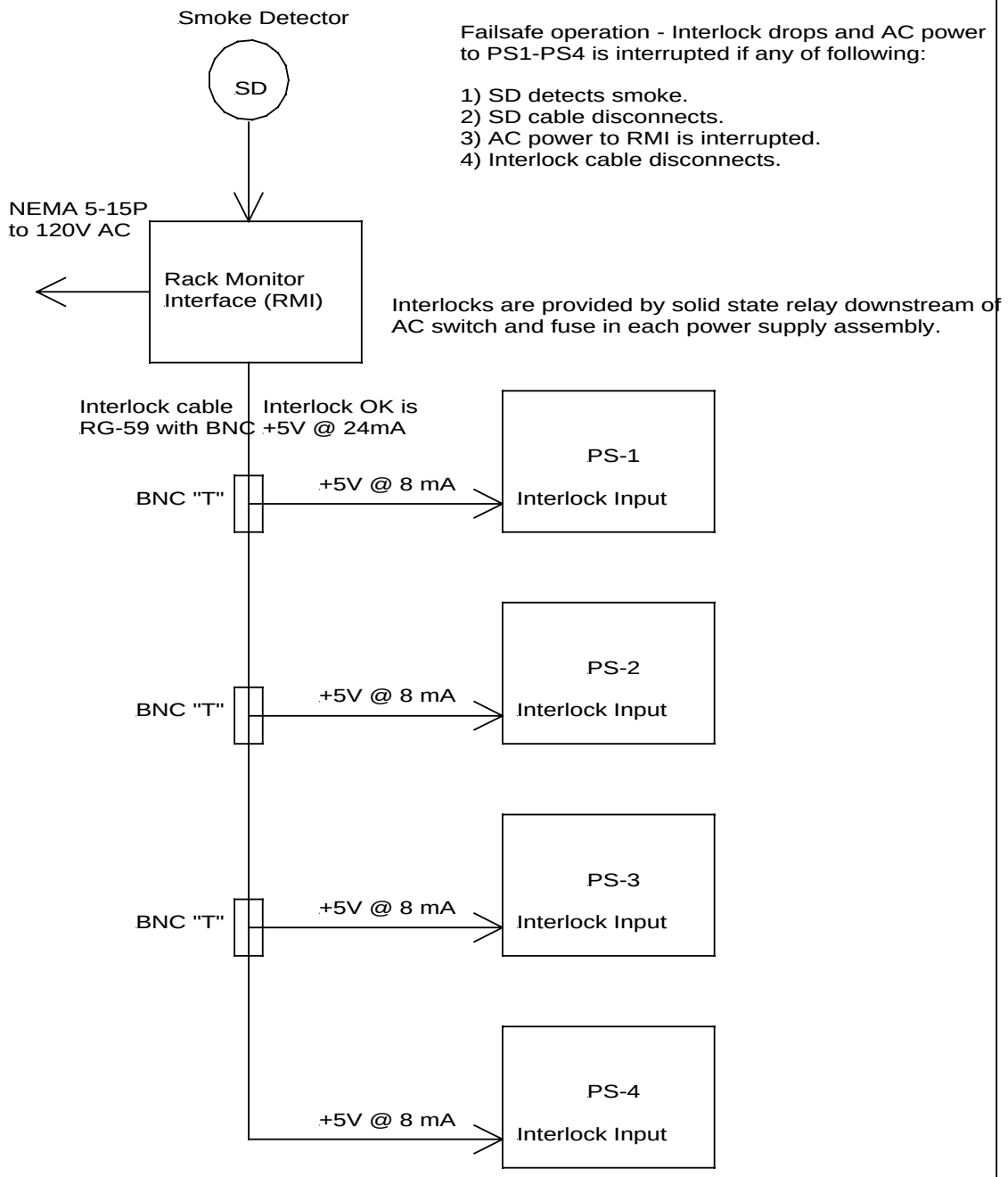

Smoke Detector
SD
Failsafe operation - Interlock drops and AC power to PS1-PS4 is interrupted if any of following:
1) SD detects smoke.
2) SD cable disconnects.
3) AC power to RMI is interrupted.
4) Interlock cable disconnects.
NEMA 5-15P to 120V AC
Rack Monitor Interface (RMI)
Interlocks are provided by solid state relay downstream of AC switch and fuse in each power supply assembly.
Interlock cable RG-59 with BNC
Interlock OK is +5V @ 24mA
BNC "T"
+5V @ 8 mA
PS-1
Interlock Input
BNC "T"
+5V @ 8 mA
PS-2
Interlock Input
BNC "T"
+5V @ 8 mA
PS-3
Interlock Input
+5V @ 8 mA
PS-4
Interlock Input

Figure 6

[1] Supplemental documentation available on request: Engineering Note, Rick Hance, H000403A, "HV Rack extension cord for sidet 10% test at Lab C".

[2] Supplemental documentation available on request: Engineering Note, Rick Hance, H000410A, "AC Requirements for HV Rack Installation at Sidet 10% Test".

[3] Supplemental documentation available on request: LAMBDA power supply manual, ASSY #25156-2.

[4] Supplemental documentation available on request: Engineering Note, Rick Hance, H930112B, "Wire Harness for Low Voltage Power Supplies in Dzero HV Crates".

[5] Supplemental documentation available on request: Engineering Note, Rick Hance, H990806A, "Efficiency of HV Pods for SiDet"

[6] Supplemental documentation available on request: User Manual, Rick Hance, "Dzero Rack Monitor Interface Chassis".

[7] Supplemental documentation available on request: User Manual, BiRa Systems, "Model VME 4877PS High Voltage Power Supply System Manual 2nd Edition March 1998". Also Hardware Manual, BiRa Systems, "High Voltage System VME-Based Model 4877, 3/24/00"

[8] Supplemental documentation available on request: Note, Marvin Johnson, "Safety Analysis of the D0 High Voltage System, June 1991".